

TRAUMA IN PREGNANCY

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SUMMARY

Trauma is the most common non-obstetrical cause of death in pregnant women. Pregnancy must always be suspected in any female trauma patient of childbearing age until proved otherwise. Unique changes in anatomy and physiology that takes place during pregnancy alter the pathophysiology and location of maternal injuries in pregnancy, which may be significantly different from the non-pregnant state. Trauma from road traffic accidents, falls and domestic violence are the most common causes of abdominal blunt trauma. As pregnancy progresses, the change of accidental injury increases. Head and neck injuries, respiratory failure, and hypovolemic shock constitute the most frequent causes of trauma related maternal death in pregnancy. Even the pregnant woman with minor injuries should be carefully observed. Initial management is directed at resuscitation and stabilization of the mother that takes precedence over that of the fetus, unless vital signs cannot be maintained and perimortem cesarean section decided upon. Fetal monitoring should be maintained after satisfactory resuscitation and stabilization of the mother. Preventive measures include proper seat belt use and identifying and counseling victims of suspected domestic violence.

Keywords : *Pregnancy, Trauma, Placental abruption, Abortion, Resuscitation.*

Today, socioeconomic conditions, inability to support families on a single income, and desire to pursue careers, have placed more women outside the home and at greater risk to undergo trauma. Even women who are not employed outside of home are at risk. Violent assault at the gravid abdomen was reported to occur in 1 in 12 pregnant women from an inner city population¹.

Women of childbearing age are among the population at greatest risk of trauma. A review by Connolly and co-workers² of pregnancies complicated by trauma from 1987 to 1993 at the University of North Carolina Hospitals in Chapel Hill, North Carolina, and the Women's hospital in Greensboro, North Carolina revealed a risk distribution of trauma cases. A total of 54.6% of the incidents were motor vehicle accidents: 22.3% were domestic abuse and assaults, 21.8% were associated with falls, and 1.3% were secondary

to burns, puncture wounds, or animal bites². This review will discuss current considerations for the optimal anesthetic management of pregnant trauma victims.

General considerations

It is essential to remember that the management of the reproductive – age female trauma victim (at the scene of an accident, in the emergency room as well as in the operating room) should always incorporate an uncertain obstetric (possibly pregnant) status. Pregnancy must always be suspected (until proved otherwise) in any female trauma patient of childbearing age. The difficulty in the anaesthetic management of pregnant trauma victims increases from elective, to urgent, to emergent situations.

Anatomical and physiological alterations in pregnancy (Table 1)

The adequate management of pregnant trauma victim requires the clinician to consider and understand the unique changes in anatomy and physiology that take place during pregnancy. The pathophysiology and location of maternal injuries in pregnancy may significantly differ from those that commonly occur in the non-pregnant state³.

During pregnancy the size of the uterus gradually increases and becomes more vulnerable to damages both by blunt and penetrating injury. The uterus remains an intrapelvic organ until the 12th week of gestation, when it begins to rise out of the pelvis and encroaches the peritoneal cavity. By 24 weeks, the uterus will be at the level of the umbilicus. At 36 weeks uterus reaches its maximal supraumbilical extent. The fetus at first is well protected by the thick walled uterus and large amounts of amniotic fluid. The amniotic fluid itself could be a source of embolism and

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disseminated intravascular coagulation following trauma. Furthermore, enlargement of the uterus reduces the confines of the intraperitoneal space, restricting the intestines to the upper abdomen.

Table - 1 : Alterations in pregnancy.

System	Changes	Special implications
Cardiovascular	- Peripheral vascular resistance, - venous return, - blood pressure (10 – 15 mm Hg)	Supine hypotension syndrome
Hemopoetic	- Plasma volume, - RBC volume, - WBC (20,000 WBC/mm ³) Hypercoagulable, - fibrinogen, - factor VII, VIII, IX, X, XII, fibrinolysis	Physiologic hypervolemia may mask hypotension secondary to blood loss! Venous thromboembolism
Respiratory	- Subcostal angle (69 – 103°), - chest circumference (5 – 7 cm), - diaphragmatic excursion (1 – 2 cm, elevated diaphragm), - tidal volume, - FRC, - Pco ₂ , - HCO ₃	Alteration in FRC and lung volume, chronic compensated respiratory alkalosis
Gastrointestinal	- Motility, - sphincter competency (progesterone), organ displacement	Regurgitation, aspiration, Clinical examination unreliable
Renal	- Glomerular filtration rate (95%), - renal plasma flow (50%), - creatinine clearance, [?] Creatinine and BUN, Dilatation of collecting system, - bladder/urethral muscle tone	Hydronephrosis, hydroureter
Musculoskeletal	Pelvic ligaments soften	Pelvic widening, lordosis, shift in centre of gravity

The heart rate gradually increases 15-20 beats/minute during pregnancy. The blood pressure is usually 15mm Hg lower than normal at the end of pregnancy. Cardiac output is increased by approximately 1.5 liters per minute. During the third trimester many women suffer from vena cava compression in the supine position. This may lead to severe hypotension. Normal respiratory changes during pregnancy are referred to as “physiological hyperventilation”. This is characterized by increased tidal volumes, normal respiratory rate, and respiratory alkalosis.

The placenta reaches its maximum size by 36 to 38 weeks of gestation and is devoid of elastic tissue. Thus, the lack of placental elastic tissues predispose to shearing forces

between the placenta and uterine wall leading to such complications as abruptio placentae. Direct trauma to the uterus and placenta releases high concentration of placental thromboplastin or plasminogen activator from the myometrium. The agents have both advantages and disadvantages for the pregnant trauma victim.³⁻⁵

Airway considerations

The anatomical and physiological factors that place the pregnant patient at increased risk of airway management complications and difficult intubation include pregnancy induced generalized weight gain and particularly an increase in breast size, respiratory tract mucosal edema, decreased functional residual capacity (FRC), and increased oxygen consumption. Therefore, the use of a short handled laryngoscope has been widely recommended in obstetric patients. In addition, placing the patient in the sniffing position helps to keep the laryngoscope handle away from the breasts⁶. Furthermore, laryngeal edema may inhibit the passage of a standard size endotracheal tube, despite adequate vocal cord visualization at laryngoscopy, and require a smaller internal diameter tube size.⁷

Obstetric considerations

Trauma to the gravid uterus threatens both the mother and the fetus.^{4,8} The fetus is dependent on its mother for its oxygen requirements, hence, an uninterrupted supply of oxygenated blood must be provided to the fetus at all times. Therefore, the timely treatment of hypotension is essential in all reproductive age female victims irrespective of whether or not a pregnancy is known to be present perioperatively.^{4,9} To avoid aorto-caval compression by the gravid uterus, the pregnant patient should be transported and evaluated on her left side (unless a spinal injury is suspected).

Despite successful resuscitative measures when a viable fetus shows signs of distress, a cesarean delivery must be performed expeditiously. However, a non viable fetus may be managed conservatively in utero to optimize maternal oxygenation and circulation.

Mechanism of injury

Most mechanism of injury are similar to those in the nonpregnant patient. However, certain differences must be recognized in the pregnant patients. As pregnancy progresses, the chance of accidental injury increases by the end of third trimester. Minor trauma occurs more frequently than at any other time during female adulthood. Alterations of the centre of gravity caused by the enlarged uterus, as also the pelvic ligament laxity are responsible for the gait instability which causes pregnant women to be more susceptible to injury by falls.

Types of trauma

Blunt abdominal trauma

Approximately 40% of blunt traumas during pregnancy are due to motor vehicle accidents. Another 30% are due to falls and about 20% cases are due to interpersonal violence.¹⁰⁻¹⁴ As pregnancy progresses, the enlarged uterus looses the protection of the bony pelvis, but the amniotic fluid provides some protection for the fetus by absorbing the thrust of blunt trauma, dissipating the force of the blow by transmitting it equally in all directions. However, the pelvic vessels are engorged due to increased intravascular volume in pregnancy and thus there may be increased chances of retroperitoneal hemorrhage as a result of blunt abdominal trauma.

The rate of fetal mortality after maternal blunt trauma is 3.4 to 38%^{11,14,15} mostly from placental abruption, maternal shock, and maternal death.¹⁶⁻²⁰ Regardless of the apparent severity of injury in blunt trauma, all pregnant women should be evaluated in a medical setting.^{11,21}

Penetrating trauma

Penetrating trauma during pregnancy is primarily the result of gunshot and stab wounds. Fetal and maternal morbidity and mortality are significantly different. Maternal mortality occurs in fewer than 5% of cases of penetrating trauma.²² During the progress of pregnancy, intra-abdominal organs change their positions. Because the bowel is pushed upward by the enlarged uterus, penetrating injury to the upper part of the abdomen is more likely to be associated with multiple gastrointestinal injuries. During the third trimester, injuries to the lower quadrants of the abdomen almost exclusively involve the uterus. This may be advantageous to the women because the uterus and the amniotic fluid absorb most of the energy of the penetrating object, resulting in less destruction of other organs.

The head injured patient

Head and neck injuries, respiratory failure, and hypovolemic shock constitute the most frequent causes of trauma related maternal death in pregnancy.³ These patients create conflicting constraints regarding their managements. These usually include: (a) an uncertain intracranial pressure (ICP; possibly elevated); (b) an uncertain cervical spine (possibly fractured); (c) an uncertain airway (possibly difficult); (d) an uncertain volume status (possibly decreased); (e) an uncertain level of consciousness (possibly comatose or combative); (f) an uncertain stomach (almost always full); (g) an uncertain oxygenation (possibly decreased); and finally (h) an uncertain obstetric status (possibly pregnant).⁷

If direct laryngoscopy is deemed necessary, an "in-line stabilization" of the head and neck by an assistant to prevent extension and rotation of the cervical spine is indicated. Otherwise, direct laryngoscopy should be avoided, and fiberoptic (awake fiberoptic) intubation of the trachea should be considered.⁹ It has been established that trauma victims with a Glasgow Coma Scale of 8 or less usually require intubation and mechanical ventilation for both airway control and control of ICP. Suxamethonium induced increase in ICP has been grossly exaggerated.²³

The ABC (airway, breathing, circulation) of resuscitation should always be an initial highest priority, which often proves life-saving for both the parturient and the fetus.⁷

Burns

May be due to thermal or electrical cause.

Thermal injury: About 5-10% of pregnant women suffer from thermal injury. The rule of nine is used to determine the percentage of total body surface area (TBSA) involved, keeping in mind that the large abdominal surface in near term patients counts for a large percentage of TBSA. The fetal death depends upon the general physical condition of the woman and the TBSA involved.

Direct inhalational injury is usually manifested as upper airway edema, which can lead to life threatening airway obstruction. However, lower airways can also be injured by exposure to smoke or toxic products of combustion. Many patients with inhalational injury, however, do not demonstrate any signs until several hours post-exposure. Major burn can alter pulmonary function even in the absence of direct lung injury.

Electrical injury: Physical damage to the woman is caused by direct effect of heat generated by the current as well as associated trauma. The type of current, its path through the body, and voltage also affect the type of injury. Most victims of electrical injury have multisystem trauma due to violent muscle contraction, skeletal fractures due to fall, and neurologic damage. The fetus is immersed in amniotic fluid, which is an excellent conductor of electrical charge. Thus, the fetus is at greater risk than the mother.

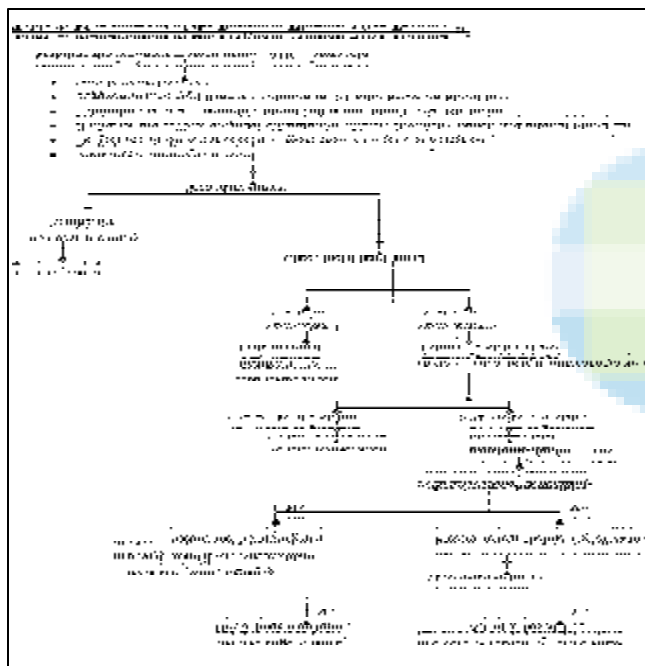
Severity of injuries

Severity of maternal injuries determines not only maternal but also fetal outcome. Therefore, the method of treatment also is dependant on the severity of maternal injuries. All traumatized pregnant women with major injuries require admission to a hospital where surgical as well as obstetric facilities are available due to high rate of mortality.

Even, the pregnant woman with minor injuries should be carefully observed since occasionally even minor injuries are associated with such complications as fetomaternal hemorrhage (the presence of fetal RBCs in the maternal circulation). Direct fetal injuries usually tend to occur in late pregnancy, and are typically associated with serious maternal trauma.

Management (Table 2)

Management of the pregnant patient sustaining trauma actually involves management of two patients. The resuscitation and stabilization should be modified to accommodate the pregnancy changes of injured women. The health of the mother takes precedence over that of the fetus and is of primary concern unless vital signs cannot be maintained in the mother and perimortem cesarean section must be entertained.



Primary survey

The best way to treat the fetus is to treat the mother. Therefore, the approach to the pregnant patient is not different than the approach to the non-pregnant patient. An *airway* should be obtained and maintained. *Breathing* should be supported by supplemental oxygen provided by nasal cannula, mask, or endotracheal intubation as deemed appropriate for the situation. Be aware of the physiological respiratory alkalosis in pregnant patients and act accordingly. As a result of blood loss the mother will shunt away blood from the uteroplacental circulation. Because of the increased amount of blood the mother can lose two liters of blood before clinical signs of shock will become evident.

Therefore, maternal *circulation* should be maintained with large bore intravenous catheters delivering crystalloid in the form of lactated Ringer's solution. While the large bore intravenous catheter is inserted, appropriate blood studies should be performed, including a complete blood cell count, a type and cross-match, and a baseline coagulation profile. A Foley catheter should be inserted to follow urinary output and ensure adequate intravascular fluid placement.

Rapid assessment of the neurological status should be done and a lateral cervical X-ray to be taken. While the first neurological examination is performed, the right hip of the patient is elevated. When there will be no further signs of vertebral or neurological damage, the assessment will be continued with the patient in the left lateral position, to prevent severe supine hypotension.

Secondary survey

Following the primary survey of the traumatized woman and performance of life saving measures, the secondary survey is initiated. Diagnostic peritoneal lavage may be conducted safely if the incision is made in the midline well above the fundus of the uterus. The examination of the injured woman include an assessment of uterine irritability, fundal height and tenderness, fetal heart tones, and fetal movements. Fetal heart tones can auscultated with Doppler ultrasound, stethoscope or fetoscope. Careful attention is to be paid to the presence of uterine contractions suggesting early labor. The evaluation of the perineum should include a formal pelvic examination. Cervical effacement and dilation, fetal presentation and the relationship of the fetal presenting part to the ischial spines should also be noted. (Table 2)

Admission to the hospital is mandatory in the presence of vaginal bleeding, uterine irritability, abdominal tenderness, pain or cramps, evidence of hypovolemia, changes in or absence of fetal heart tones. The fetus may be placed in jeopardy even with apparent, minor maternal injury. Initial management is directed at resuscitation and stabilization of the pregnant patient because the fetal life at this point is totally dependent on the mother's condition. Fetal monitoring should be maintained after satisfactory resuscitation and stabilization of the mother. The presence of two patients (mother and fetus) and the potential for multiple injuries emphasize the importance of a surgeon working in concert with an obstetrical consultant.

Monitoring

If possible, the patient should be monitored on her left side to avoid aortocaval compression after physical

examination. Monitoring of the central venous pressure response to fluid challenge is extremely valuable in maintaining the relative hypervolemia required in pregnancy. A correlation between the maternal bicarbonate level and fetal outcome has been suggested. Therefore, it may be useful to monitor the maternal serum bicarbonate level in addition to other hemodynamic parameters.

Fetal distress can occur at any time without warning. Although fetal heart rate can be determined with any stethoscope, the fetal heart rate and rhythm is best monitored continuously using the ultrasonic Doppler cardioscope to ensure early recognition of fetal distress. Inadequate acceleration of fetal heart rate in response to fetal movements, and/or late or persistent decelerations of fetal heart rate in response to uterine contractions indicate fetal hypoxia.

Indicated radiographic studies should be performed, because the benefits certainly outweigh potential risk to the fetus.

Cardiopulmonary resuscitation²⁴

Gestational age 24 – 32 weeks

External cardiac massage should be monitored with carotid pulse, end-tidal CO₂ (ETCO₂), and fetal heart rates. If they are found to be adequate, external cardiac massage is to be continued further till 5 minutes and return of systemic circulation is waited for. If there is no return of systemic circulation, open-chest cardiac massage is done. Otherwise, cesarean section can be done immediately to save the baby when maternal condition is not improving.

Gestational age above 32 weeks

After initiation of external cardiac massage, the carotid pulse, ETCO₂, and fetal heart rates are observed. If they are adequate, external cardiac massage is continued for 4 – 5 minutes. If after 5 minutes there is no return of spontaneous circulation, cesarean section can be done immediately. Following cesarean section, external cardiac massage may be successful. If still maternal condition is not improving, open chest cardiac massage may be tried.

Perimortem cesarean section

Perimortem cesarean section rarely is required²⁵ but is performed in the patient with a viable fetus who has been unsuccessfully resuscitated for four minutes.²⁶ Delivery within five minutes carries the best chance of fetal and maternal survival^{26,27}. If this time interval has been exceeded, one may still consider perimortem cesarean section given several case reports of intact neonatal survival with longer

arrest to delivery intervals. Delivery of the infant abdominally might also have resuscitative benefits for the mother by diminishing the fetal-placental mass and improving cardiac return and hence cardiac output.

Prevention

Motor vehicle crashes and domestic violence are common preventable causes of trauma in pregnancy.

Proper seat belt use is the most significant modifiable factor in decreasing maternal and fetal injury and mortality after motor vehicle crashes.²⁸⁻³⁰ The lap belt should be placed below the gravid abdomen, snugly over the thighs, with the shoulder harness off the side of the uterus, between the breasts and over the midline of the clavicle.²⁹ Seat belts placed directly over the uterus can cause fetal injury.³¹

Domestic violence occurs in up to 25% of pregnant women.³²⁻³⁴ Therefore, it is recommended that the pregnant woman should know the techniques to prevent domestic violence (Table 3).

Table - 3 : Domestic violence prevention technique³²

A . Partner violence screen
• Do you feel safe in your current relationship?
B . Safe screen
• <i>Stress</i> : What stress do you have in your relationship?
• <i>Afraid/abused</i> : What happens when you and your partner disagree? Has your partner ever threatened or abused or your children?
• <i>Friends/family</i> : If you were hurt, would your friends or family know? Could you tell them?
• <i>Emergency plan</i> : Do you have a safe place to go in an emergency?

Conclusion

Pregnant women represent a major challenge in trauma care because of the risks to both mother and child, and because of difficulties in following standard protocols³⁵. A pregnancy test is mandatory for all women of child bearing age who are involved in trauma.³⁶

Successful management of a pregnant woman requires an interdisciplinary approach. Anesthesiologists can contribute greatly to the care and management of these patients by virtue of their knowledge about the physiological changes of pregnancy and their familiarity with the procedure of cardio-pulmonary resuscitation. The initial resuscitation should follow advanced trauma life support.

Careful but rapid approach according to the principle of this article can reduce morbidity and mortality in pregnant

trauma patients. The first priority in the resuscitation of a pregnant trauma victim is stabilization of the mother, and only then should attention be directed to the fetus.

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